AUDIT

Early discharge after acute myocardial infarction: risks and benefits

P Wilkinson, R Stevenson, K Ranjadayalan, B Marchant, R Roberts, A D Timmis

Abstract

***Background*—Thrombolytic treatment reduces mortality in patients with acute myocardial infarction but is associated with recurrent thrombotic events after admission, and it is unclear whether current practices of early hospital discharge are safe. Timing of first major adverse events (death, reinfarction, unstable angina, secondary ventricular fibrillation) in the early post-infarction period was studied to determine the risks.**

***Design*—Follow up study.**

***Patients*—608 consecutive patients (447 men and 161 women) with confirmed myocardial infarction who were admitted to the coronary care unit of a district general hospital between January 1989 and December 1991. Clinical details, including the development of left ventricular failure and in hospital adverse events, were recorded prospectively. Follow up for out of hospital adverse events was carried out by review of the case notes, postal questionnaire, and where necessary, by telephone contact with the patient and his general practitioner.**

***Results*—The risk (95% confidence interval) of major adverse events in the first 10 days was 32·3% (26·3 to 39·4%) in patients with heart failure and 7·3% (5·1 to 9·2%) in those without. Smoothed estimates of the event rate in patients without heart failure decreased from 5·9 events/1000 persons/day on day 6 to 3·4 events/1000 persons/day on day 10 and 0·9 events/1000 persons/day on day 21. The corresponding cumulative risk estimates suggest that about 11 in every 1000 patients suffer a major, but often unpreventable, adverse event on day 6 or 7 after admission, and 23 in every 1000 do so between days 6 and 10.**

***Conclusions*—The point at which the risk to the individual becomes acceptably low is a matter of judgement, but the risk of a major adverse event declines rapidly after a heart attack, and particularly for patients without heart failure discharge within a few days may be appropriate. Prolonging stay unnecessarily may use resources which could be more effectively used to treat cardiac disease in other ways.**

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Clinicians continue to debate the safety of discharging patients early from hospital after a heart attack.[1] The desire to minimise the patient's hospital stay is in part driven by the wish to allow him to return home as soon as possible, and partly by the pressure to reduce the costs of health care. Against this have to be set the patient's safety and his need for rehabilitation. Over the past 25 years the lengths of hospital stay have fallen substantially,[2,3] but there may be considerable variation between hospitals.[4,5] The risk of death or other serious events is greatest in the first few days but rapidly decreases and studies from the late 1970s and early 1980s suggested that patients with an uncomplicated course may be discharged safely after a week, and some low risk patients even sooner.[6-11] A recent study suggests the feasibility of using simple clinical variables to identify low risk patients (treated without thrombolysis) who may be suitable for discharge as early as 4 days after myocardial infarction.[12]

Thrombolytic treatment reduces hospital mortality,[13,14] but is associated with recurrent thrombotic events, and it is unclear how this affects the safety of early discharge.[15,16] The risks of major adverse events in general hospital patients has not been systematically quantified since the introduction of thrombolysis, yet lengths of stay continue to decrease. We have previously reported the follow up of a consecutive series of patients with confirmed myocardial infarction from a district general hospital in east London[17] and we have used data from this study to examine the risk of major adverse events in the early post-infarction period.

Patients and methods

The methods are described in our previous report but are summarized here.[17] The study population comprised 447 men and 161 women admitted to the coronary care unit of Newham General Hospital between January 1989 and December 1991. Twenty five patients were admitted twice, giving 633 separate admissions. During the study period it was policy to admit all patients with suspected myocardial infarction to the coronary care unit regardless of age.

Clinical details were recorded prospectively. The diagnosis of myocardial infarction

required two of the following three criteria: typical chest pain; > 0·1 mV ST elevation in at least one standard lead or two precordial leads of the electrocardiogram, and a rise in serum creatine kinase to at least twice the normal laboratory value (> 400 IU/l). The diagnosis of left ventricular failure indicates that the patient was breathless, had basal crepitations or a third heart sound, or both, and required treatment with diuretics. Primary ventricular fibrillation was ventricular fibrillation occurring in the first 24 h. It was not classified as a major adverse event, but secondary ventricular fibrillation—that is, occurring after 24 h, was considered to be a major adverse event.

Major adverse events (death, recurrent myocardial infarction, unstable angina, secondary ventricular fibrillation) during admission were recorded at the time; follow up for out of hospital events was carried out in June 1992 by review of the case notes and postal questionnaire to the patients. Non-responders were telephoned. Details of relevant events were checked with the general practitioner. Follow up was complete in 596 patients and censored at discharge in a further ten. Reliable information about major adverse events could not be obtained on two patients who were thus excluded from analysis.

During the study period, clinicians did not have a uniform policy on when to discharge patients after uncomplicated myocardial infarction. Their reported policies ranged from 7–12 days in 1988 to 5–8 days in 1991. Overall the median length of stay was nine days, but the mode fell from nine days in 1988 to seven days in 1991.

STATISTICAL METHODS

All analyses were based on the first admission for each patient during the study period. For the 25 patients admitted twice with myocardial infarction the second admission was recorded as a major adverse event.

Event free survival estimates were based on the Kaplan-Meier method.[18] Multivariate predictors of adverse events in the first 10 days were obtained from logistic modelling, with improvements in model fit based on the likelihood ratio statistic.

The rate of major adverse events was calculated for each day after admission. The rate (λ_i) for the i^{th} day was d_i/n_i, where d_i was the number of people who developed a major event on the i^{th} day and n_i the number still free of major events by the i^{th} day. Smoothed rate estimates were obtained by Poisson regression,[19] with the log rates modelled as a polynomial function of days since admission.

Results

Some 196 patients (32%) developed clinical evidence of heart failure (left ventricular failure with or without cardiogenic shock). These patients were older than those without heart failure, a higher proportion were women, and more were diabetic or had a history of previous infarction; a smaller proportion had received thrombolysis (table 1). Seventy five patients eventually underwent revascularisation, but only 18 did so in the first 10 days: two (1%) of those with heart failure and 16 (4%) of those without.

Table 2 gives multivariate predictors of adverse events within 10 days. Heart failure was the most important, with an odds ratio of 3·47. The probability of developing a major event by 10 days was 32·3% (95% confidence interval (CI) 26·3 to 39·4%) in patients with heart failure and 7·3% (95% CI 5·1 to 9·2%) in those without (fig 1). Older age, female sex, the presence of bundle branch block, and ventricular tachycardia were associated with increased risk, but primary ventricular fibrillation was not. Thrombolysis and aspirin use were associated with lower risk.

Table 1 Patients' characteristics by left ventricular function

	Patients without heart failure (n = 412)	*Patients with heart failure (n = 196)*
Age group (year)		
< 50	79 (19)	16 (8)
50–59	133 (32)	36 (18)
60–69	120 (29)	65 (33)
70 +	80 (19)	79 (40)
Sex		
M	321 (78)	126 (64)
W	91 (22)	70 (36)
Race		
White	312 (76)	156 (80)
Indian sub-continent	90 (22)	38 (19)
Other	10 (2)	2 (1)
Diabetes		
Yes	55 (13)	63 (32)
No	357 (87)	133 (68)
Smoking		
Never smoked	95 (23)	65 (33)
Ex-smoker	63 (15)	35 (18)
Current	254 (62)	96 (49)
Previous infarction:		
Yes	81 (20)	71 (36)
No	331 (80)	125 (64)
Thrombolysis/aspirin treatment		
Thrombolysis and aspirin	281 (68)	106 (54)
Thrombolysis only	37 (9)	17 (9)
Aspirin only	68 (17)	35 (18)
Neither	26 (6)	38 (19)
Probability of major complication within 10 days (%)	7·3	32·3

Values in parentheses are percentages.

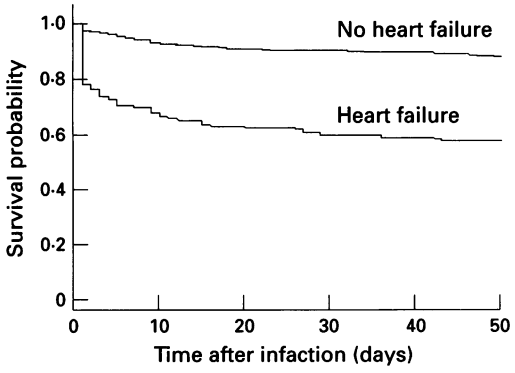

Figure 1 Event free survival by left ventricular function.

Table 2 Multivariate predictors of a major adverse event within 10 days of infarction

	Odds ratio	*95% Confidence interval*	*Likelihood ratio statistic*	*dF*	*P Value*
Heart failure					
No	1				
Yes	3·47	2·06 to 5·85	22·3	1	< 0·001
Thrombolytic treatment					
No	1				
Yes	0·49	0·29 to 0·85	6·30	1	0·012
Aspirin treatment					
No	1				
Yes	0·50	0·28 to 0·90	5·16	1	0·023
Bundle branch block (BBB)					
None	1				
Right BBB	2·64	1·25 to 5·58	13·7	2	0·001
Left BBB	4·52	1·75 to 11·6			
Ventricular tachycardia					
No	1				
Yes	2·42	1·10 to 5·31	4·52	1	0·034
Age group (years)					
⩽ 60	1				
> 60	2·05	1·15 to 3·65	6·11	1	0·013
Sex					
M	1				
F	1·69	0·99 to 2·89	3·62	1	0·057

RATES OF ADVERSE EVENTS

The rate of major adverse events was analysed separately for patients with and without heart failure because of the prognostic importance of ventricular function. Figure 2 shows the change over time for the two groups. Patients with heart failure had a high rate in the first few days which rapidly diminished. The regression fit suggests that the incidence fell from 21·3 events/1000 persons on day 6 to 9·0 events/1000 persons on day 10 and 3·6 events/1000 persons on day 21. Rates in those without heart failure were substantially lower with corresponding figures at 6, 10, and 21 days of 5·9, 3·4, and 0·9 events/1000 persons/day.

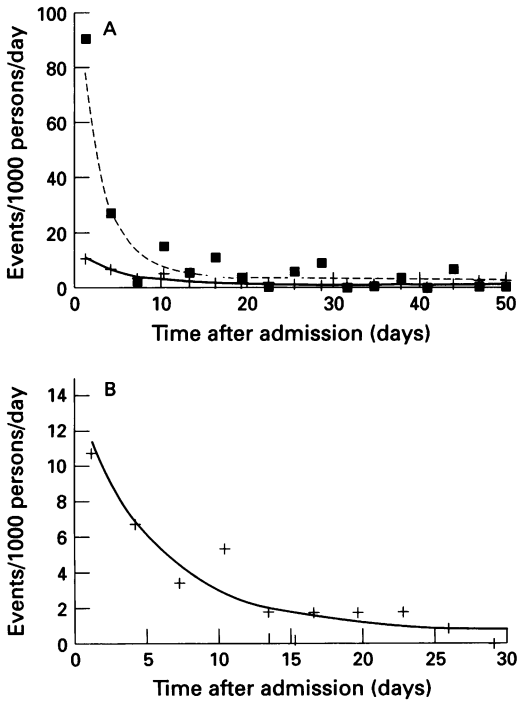

Figure 2 Rate of major adverse events after admission. (A) Solid points show 3 day means for patients with heart failure and the dashed line the corresponding regression fit (using data for individual days). Three day means (crosses) and the regression fit (solid line) for patients without heart failure are also shown in (A) and again in (B) using expanded x and y axes.

The cumulative risk in this group was 1·1% between days 6 and 7 and 2·3% between days 6 and 10.

A total of six adverse events were actually observed on days 6 and 7 in patients without heart failure, which represents an event rate for these two days of 7·65 (95% CI 2·81 to 16·7) events/1000 persons/day. This is slightly greater than the smoothed estimate from the regression fit. Over the five day period of days 6–10 13 patients without heart failure developed a major event; the corresponding rate was 6·72 (95% CI 3·58 to 11·49) events/1000 persons/day—again higher than the smoothed estimate.

Table 3 gives the characteristics of those without heart failure who developed a major adverse event between days 6 and 10. There were four in hospital deaths, five non-fatal reinfarctions, and three readmissions with unstable angina. The single episode of secondary ventricular fibrillation occurred immediately after coronary angiography. This table indicates that of 412 patients without heart failure, only five developed a major adverse event shortly after hospital discharge.

Review of the case notes suggested that of the 13 patients who developed a major adverse event between days 6 and 10, only five would probably have been fit for discharge after five days because of various medical problems. One of these died in hospital on day 6, one developed unstable angina on day 10, and three had reinfarction (one on day 8 and two on day 10).

COSTS AND BENEFITS

It was not possible to quantify all costs and benefits of early discharge, but estimates were obtained of the potential saving on hospital care, and the expected additional number of adverse events which would occur outside hospital. The latter was computed from the smoothed estimates of risk, and the breakdown of different types of event—that is, death, reinfarction, secondary ventricular fibrillation, and unstable angina, was based on the proportions observed between 6 and 10 days. The calculations assume that all patients would be fit for discharge after five days and that the same complications would occur whether the patients were in hospital or at home.

For 1000 patients without heart failure discharge after five days rather than seven would increase the number of out of hospital events by about 10·9: 3·4 deaths, 0·8 episodes of secondary ventricular fibrillation, 2·5 recurrent heart attacks, and 4·2 episodes of unstable angina. The cost of a bed on a general medical ward was estimated to be £140 per day, excluding specific investigation and treatment. Thus, for 1000 patients the approximate saving would be 2000 bed days at a nominal cost of £280 000, although it may not be possible to redirect these resources to other uses.

Discharge after five days rather than 10 would save 5000 bed days at a cost of £700 000 but be accompanied by the following out of

Table 3 Characteristics of patients without heart failure who suffered a major adverse event between days 6 and 10 after admission

Event and day on which it occurred	Hospital stay (days)	Age (years)	Sex	Thrombolysis	Comments
Death day 6	6	74	M	Yes	Died in hospital
Death day 6	6	69	M	No	Patient had carcinoma of the stomach
Ventricular fibrillation day 6	14	67	M	Yes	Ventricular fibrillation occurred immediately after angiography
Myocardial infarction day 6	15	62	M	No	Retroperitoneal bleed on day 5
Death day 7	7	75	F	Yes	Died at night in hospital
Myocardial infarction day 7	6	80	M	No	Discharged day 6
Unstable angina day 8	6	58	F	Yes	Diabetic. Discharged day 6
Myocardial infarction day 8	21	62	F	Yes	Myocardial infarction in hospital. Well on days 5 and 7
Unstable angina day 10	7	58	F	Yes	Angioplasty on day 2. Readmitted with unstable angina
Unstable angina day 10	5	58	F	Yes	Discharged day 5
Death day 10	10	69	M	No	Well on day 6. Died on day of discharge
Myocardial infarction day 10	20	68	M	No	Equivocal chest pain on day 5, so not discharged
Myocardial infarction day 10	9	77	M	No	Readmitted with myocardial infarction

hospital complications: 6·9 deaths, 1·7 episodes of secondary ventricular fibrillation, 5·2 recurrent infarcts, and 8·7 episodes of unstable angina.

Discussion

This study examined a consecutive series of patients admitted to a district general hospital since thrombolytic treatment became routine in the management of myocardial infarction. As an observational study, it shows the outcome of patients who were subjected to a variety of different policies for investigation, mobilisation, and discharge, in the normal clinical setting. It does not answer the question of whether early discharge increases or decreases the frequency of complications, but it does provide a guide to the risk of death and other major adverse events in the early post-infarction period which should help clinicians formulate their own discharge policies.

Of the determinants of early outcome, heart failure was the most important and we used this factor to divide patients into high and low risk groups. The size of the study population does not allow the shape of the risk functions to be defined with precision and the smoothed estimates were slightly lower than observed values between six and 10 days. The rates should therefore be viewed as approximate indicators rather than precise estimates. Nevertheless, patients without heart failure clearly had a low absolute level of risk (less than 1% a day within three days of admission) which steadily declined. As there was no obvious point at which the decreasing risk reached a plateau, it becomes a matter of judgement to decide when the risk is acceptably low for safe discharge.

The risks have to be balanced against potential benefits. Delaying discharge ensures that more patients who develop adverse events receive immediate medical attention. Early discharge puts at risk a small additional number of patients and reduces the time available for in hospital rehabilitation and investigation (such as pre-discharge exercise electrocardiography), but may also have physical and psychological benefits. The resource implications may be substantial: the additional cost of hospital care amounts to around £25 000 for each major complication on days 6 and 7 after admission, and many of these complications are not preventable. It is worth noting, for example, that in our study all deaths between six and 10 days occurred in hospital. Thus, early discharge could potentially save considerable resources which might be more effectively used to treat coronary disease in other ways.

The timing of discharge for patients with heart failure is often determined by clinical factors, but clinicians should be aware that for many patients without heart failure the risks of an adverse event are small and it seems reasonable to consider their discharge at five days or sometimes even earlier. Of course, each case must be decided individually on the basis of clinical assessment and any general policy flexibly applied. It may be appropriate to allow the early discharge of young, fit patients with good family support, but clinical judgement is always important and it is often social circumstances which dictate the timing of discharge rather than purely clinical considerations.

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